Addressing Skin Failure Through Support Surface Selection in Hospice Care

Preserving Skin Integrity while Maximizing Comfort

SUMMARY:
Due to factors known collectively as “skin failure,” skin integrity for end of life patients is often compromised. Therefore, wound healing is not always possible. In many cases, a more realistic goal for hospice providers is to maximize comfort and restful sleep while minimizing shear induced damage to weakened, friable skin. A newly developed, specialized support surface was evaluated in seven hospice organizations. The surface was found superior in both comfort and prevention of further damage to skin integrity as compared to the powered and non powered surfaces typically available to hospice care providers.
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Introduction

The National Hospice and Palliative Care Organization (NHPCO) defines Hospice care as “a model for quality compassionate care for people facing a life limiting illness”. The primary goal of hospice care is to maximize patient comfort, quality of life, and relief of suffering, while achieving the highest possible level of dignity and function. Hospice care does not seek to cure a patient. Rather, its goal is to provide medical care, pain management, emotional and spiritual support.

According to the most current figures from the NHPCO, during 2009 there were 1.56 million patients in the U.S. who received care from hospice organizations. This represents nearly 42 percent of all U.S. deaths and this percentage continues to grow.

Hospice Care and Pressure Ulcers

As this patient population continues to increase, so do the challenges faced by caregivers. Particularly vexing is the challenge of maintaining skin integrity in these extremely compromised patients. A study by Hanson, Langemo, & Olson showed that 62.5 percent of pressure ulcers in hospice patients occurred in the two weeks before death. A more recent study of 383 patients found that of the 35 percent (134) with wounds, half were pressure related.

Systemic challenges to skin integrity:

Skin Failure.

Given the prevalence of ulcers, it is natural that hospice providers feel compelled to prevent and treat them. But in most cases, this is not a realistic goal. Worse, when wound healing is not achieved, it is generally viewed as an indication that the care provided was somehow inadequate or absent. More likely, though, failure to maintain a hospice patient’s skin integrity is related to a condition known as “Skin failure”, and as such, is unavoidable.

“Skin failure” is a term found in the literature and popularized by Langemo & Brown. Skin failure is defined as death of the skin (as an organ) and underlying tissues resulting from hypo-perfusion secondary to multi-system organ failure which occurs as part of the dying process.

During the dying process blood is shunted away from the skin to major organs such as the heart, lungs, and brain in an attempt to maximize systemic functioning. This deprivation of life-sustaining blood and nutrients is an inherent aspect of the process of organ and skin failure. As the process continues, multiple organs fail and the skin breaks down. This presents additional challenges for patients already experiencing the effects of their underlying illness, limited mobility, poor nutrition, and dehydration.

Considering these physiological impairments, McManus argues that wounds at the end of life rarely can be healed and should be considered stable and non-healing wounds.

Mechanical challenges to skin integrity:

Shearing and friction

Clearly, the effects from internal changes secondary to multi-organ system failure represent a huge challenge to skin integrity. However, barriers to skin integrity from the inside are only part of the problem. Poor skin integrity in hospice patients is also compounded by their extreme susceptibility to physical forces that cause damage from the outside.

The compromised skin of hospice patients is often described as friable. Friable skin is thinner, less elastic, and extremely prone to tears and other damage caused by mechanical forces including pressure, friction, and shearing. These forces primarily come into play when moving the patient. As a result, hospice caregivers are trained to exercise extreme caution when transferring or repositioning patients on a support surface. This can help reduce the incidence of skin tears secondary to immobility. Cautious care can also help offset the tendency for skin and tissue injury caused by shearing. Shearing refers to the destructive mechanical force created when layers of skin and tissue shift relative to each other while trapped against a bony prominence. It is particularly evident in

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hospice patients, in whom weight loss results in more prominent heels, sacrum and scapula. Damage often occurs when these poorly protected prominences dig into an unforgiving support surface during transfer, repositioning and head-of-bed elevation.

Systemic challenges to skin integrity:
Given the unique challenges presented by the hospice patient, it is clear that the choice of support surfaces has a tremendous impact on patients and caregivers alike.

Ideally, the surface would accomplish the primary goal of hospice care—maximizing patient comfort, and by extension, rest—while also minimizing further breakdown (and associated pain) to maintain the highest possible level of skin integrity.

Too often, however, the support surfaces prescribed in the hospice setting accomplish neither. In most cases, hospice patients are placed on standard homecare style foam mattresses, alternating pressure pads, or gel overlays. While these options are affordable they are commonly perceived as minimally comfortable at best. Worse, they do little to protect friable skins from injury cause by pressure, shear or friction.

Proposed Solution
Caregivers in seen different hospice organisations agreed to trial a specialised support surface*. The product trialed was designed specifically to address the two most important support surface-related needs of the hospice patients: maximizing their comfort and protecting their skin.

The surface that was evaluated featured a proprietary, self-adjusting internal air chamber system for pressure management and immersion. The air system was enclosed in a patented foam shell with firm perimeter bolsters for patient safety and stability during transfers and edge-of-bed sitting. The top of the shell was formed from a specialty foam material selected for its extreme comfort. It featured a unique, segmented surface pattern composed of individually adjusting support cells designed to minimize the effects of shearing cells designed to minimize the effects of shearing and friction. Running laterally between these segments, air channels cut into the top surface were designed to help keep the patient cool and dry by ventilating excess heat from the surface. The underside of the conforming stretch fabric cover featured proprietary, silicone-coated zones designed to allow the scapula, sacrum, and heels to ‘glide’ on the surface without digging into the mattress. Overall, the combination of air system, foam shell and specialty cover was designed to provide a level of comfort far superior to typical support surfaces.

Data:
Seven hospice care organisations evaluated the specialised mattress system on a total of 32 patients, (17 males, 15 females). Average patient age was 76 years and the average weight was 185 pounds. Of the seven organisations, four were agencies in the home setting, two were free standing hospice houses, and one was located within an in-patient long-term care facility. Diagnoses included cancer, dementia, congestive heart failure, and chronic obstructive pulmonary disease.

Results:

<table>
<thead>
<tr>
<th>Positive Responses</th>
<th>100.0%</th>
<th>98.0%</th>
<th>93.8%</th>
<th>90.6%</th>
</tr>
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<tbody>
<tr>
<td>Improved patient comfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved protection of patients’ intact skin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved patient mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would recommend surface</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
ADDRESSING SKIN FAILURE THROUGH SUPPORT SURFACE SELECTION IN HOSPICE CARE

Preserving Skin Integrity while Maximizing Comfort

Three areas of importance were evaluated relative to previously used products: improved patient comfort, protected intact skin and improved patient mobility. The results: 90.6 percent reported that the support surface improved patient comfort; 93.5 percent reported that it improved protection of patient’s intact skin; 98.0 percent reported that it improved patient mobility in patients who were able to move. Interestingly, 29 percent reported that it actually helped improve existing breakdown, which is significant within this terminally ill and poorly healing population. In addition, patients’ comments included; “the surface made it easier to get out of bed and move myself,” “more comfortable”, and “more restful sleep”.

Summary and Conclusion
Hospice patients are a specific and vulnerable population with unique needs related to multi-system organ failure. In light of this, healing wounds is often not a realistic goal. Instead, the goal is to maximize comfort while protecting intact skin. The products most often prescribed in the hospice setting are typically ineffective for achieving these goals.

Seven hospice organizations trialed a specialized support system. The results showed that the surface evaluated represents a promising new tool to care for this terminally ill and poorly healing population. The results also indicated that the product’s unique design protected friable skin, maximized comfort, and reduced pressure and shearing forces more effectively than previously prescribed products.

Overall, 100 percent of the clinicians that participated reported being satisfied with the product’s performance, and indicated that they would highly recommend it for future use. All seven hospice organizations have continued prescribing this specialized support surface following the evaluation. Based on these results, it is reasonable to conclude that clinicians choosing this specialized support surface can feel secure knowing that they are providing a very high level of prevention, comfort, and safety to their most vulnerable patients.

References

Evaluation product provided courtesy of Span-America Medical Systems, Inc.
Support surfaces are often assessed for their ability to affect tissue by managing pressure, shearing, heat, and moisture. However, the support surface must also keep the patient safe as they ingress, egress, and roll in order to prevent falling to the floor or entrapment against the siderail.  

As a patient sits on the edge of a mattress, instability of the edge causes patients to fall. As the edge collapses, the resilience of the inner part of the mattress, in effect, pushes the patient off of the edge, causing the patient to push back with their lower extremities. Which mattresses are safest for edge sitting, as indicated by those that cause the least pressure at the knee? 

As a patient lies on the mattress, there is balanced compression as the body immerses into the surface. As they move toward the edge and initiate a sideroll in order to sit up, the mattress compresses in an unbalanced manner as the edge collapses, the resilience of the mattress center pushes up and the patient is pushed from the mattress. This would incite either a fall from the edge, or entrapment into the siderail. Again, which mattress is safer? 

**Goals:** To pilot two laboratory tests to objectively measure the stability that a mattress provides the patient as they 1) sit on the edge of the mattress to get in (ingress) or get out (egress) of the bed, and 2) roll toward the edge either during sleep or in preparation for egress.

Five mattress styles were used for each test: 

1. Visco-elastic or memory foam 
2. Alternating air with horizontal cylinders and air filled side bolsters 
3. Alternating air/low-air-loss combination with horizontal cylinders 
4. Foam – high density open cell 
5. Alternating air with high density open cell foam side bolsters and top surface 

**Data:** Average maximum force generated at the force gauge at knee height. 

![Graph showing force gauge at knee height](image)

**Results:** Lower force means less patient effort and less force pushing occupant out of the surface.

Mattresses with high density open cell foam edges require the least force at the knee joint and are safest for edge sitting.

**Discussion:** In sitting, there are definite differences between the foam edged products and the air or visco edged products. Mattresses with high density open cell foam edges require the least force at the knee joint and are safest for edge sitting. The air with foam bolsters mattress was 30% more stable than air-only, 41% more stable than air with air bolsters, and 37% more stable than visco-foam. 

When rolling from supine, two data points must be combined to measure edge safety. It is the combination of the most force with the widest point that gives the patient the largest safety range. As the "patient" rolled toward the edge of each product, the air mattress with foam bolsters kept the patient safe over a wider width of the mattress and with more support at the edges than the air or visco-edged mattresses. This support might be reflected in more stable bed positioning and more independence in ADL’s.

The distance measurement also showed marked differences between products. The air and visco edged mattresses had 20–50% less width than the air with foam bolsters mattress; that is, they collapsed sooner.

**Conclusions:**

1. These two tests seem to be sensitive enough to show differences between products.
2. Mattresses with high density open cell foam edges appear to be significantly more stable for edge-sitting than mattresses with air-filled or viscoelastic foam edges.
3. Mattresses with high density open cell foam edges appear to give the safest combination of a high force at the widest points of the mattress surface needed for edge collapse.

**References:**

Objectively Testing Edge Stability of Support Surfaces

Evan Call, EC Services; Nathan Call, EC Services; Laurie M. Rappl, PT, CWS, Span America Medical Systems, Greenville, SC

The majority of powered support surfaces on the US market have air cylinders oriented in a lateral or side-to-side configuration; a minority of powered surfaces have air tubes oriented in a longitudinal or head-to-foot configuration. This imbalance of products leads to the assumption that lateral configurations are better at pressure management than longitudinal configurations. This assumption requires testing. Objective testing in a laboratory setting, with pressure mapping as an objective measure, might help to prove or disprove the assumption of effectiveness related to the configuration of air cylinders in support surfaces.

**GOAL:** We set out to determine in a laboratory setting whether lateral cylinder configurations were, indeed, better at managing pressure than longitudinal configurations. Pressure management performance was quantified by recording interface pressures in each of three settings:

1. **Pressures with the bed in the flat position** – The measurements of maximum pressures were recorded in a flat position after the head of the bed had been elevated to 30° ("returned to flat" position). Interface pressures change as the patient moves. Recording maximum pressures after the patient raises and lowers the head of the bed may be more representative of the "real world" as it takes into account accommodation of the support surface and the patient’s tissues after movement.

2. **Amount of surface accommodation to movement** – Difference in peak pressures between the returned-to-flat position and the initial flat position measure how much accommodation occurs between the bed and the patient after raising and then lowering the head of the bed. This was calculated on a percentage basis.

3. **Pressures with the head of the bed (HOB) elevated 30° ("gatched")** – Sacral pressures increase as the head of the bed is elevated. Since this position is often used for patient comfort, during meal times, and for self care needs, knowing the effects of a support surface on the sacral area in this position is helpful to the clinician.

**METHOD:** Although interface pressure mapping does not always directly correlate to subcutaneous pressures, it does provide a somewhat objective method of comparing the performance of various surfaces on the same body, and comparing trends in various bodies on the same surfaces. For this study, we used the Force Sensing Array (FSA) by Vista Medical, Winnipeg, Canada.
Comparing Lateral and Longitudinal Air Cylinder Configurations in Support Surfaces

By Todd Batt, BSME, Rehabilitation Engineer

Surfaces used: Two surfaces by established, market-leading support surface manufacturers and currently in common use in the United States were studied. Both were powered surfaces of similar construction using a pump to maintain constant inflation of air cylinders. One had the cylinders in a lateral configuration and the other had cylinders in a longitudinal configuration. Each surface was placed on the same bed frame constructed with a flat solid pan and electric head elevation. Consistent degree of head elevation was determined by a self-leveling protractor placed on the horizontal bedrail as the head was elevated.

DESIGN: We pressure mapped two subjects, the first a 5’ 3”, 120 lb. female, and the second a 5’ 10”, 180 lb. male. Each of these subjects wore similar cotton clothing, removed all objects from their pockets, and removed their shoes. They were mapped without using pillows. Each mattress was set up per manufacturer’s instructions regarding orientation on the bed frame, power supply, and inflation level.

The mat for the FSA was placed on the support surface, the subject was placed on the mat, wrinkles in the mat were straightened out, and the patient was oriented such that the hip was lined up with the point of rotation of the hip gatch in the bed frame. This was done to minimize sliding of the patient toward the foot of the bed when the head was elevated to 30°. Readings were taken in the initial flat mode, after the head was elevated to 30°, and when the bed was returned to a flat position. The FSA reads in millimeters of mercury (mm. Hg.) and provides a print out of the pressures over the entire support surface simultaneously. The FSA calculates and reports the average pressure of the sensors included in the reading, the maximum pressure recorded, and the number of sensors included in the reading. The number of sensors provides an indication of the immersion of the subject into the surface; the more sensors involved in the reading, the greater the area that is involved in managing the pressure of the subject.

RESULTS: The values from the FSA recordings used for the calculations below are shown in Table 1 for the 5’ 3” 120 lb female, and in Table 2 for the 5’10” 180 lb male.

1. Pressures with the bed in the flat position (“returned to flat”) – Longitudinal cylinders gave lower peak pressures than the lateral cylinders for both subjects. The pressures on the longitudinal cylinders were 41% better on the female subject (100 vs. 59) and 19% better on the male subject (76 vs. 64).

As an illustration, the mappings for the female subject are shown above. In the upper picture, the maximum pressures on the lateral cylinders are at least 100 mm Hg. (the FSA does not record pressures higher than 100). In the lower picture, the maximum pressure on the longitudinal cylinders was 59.

Average pressures over the surfaces were lower on the longitudinal tubes on both subjects in all positions except one, where the pressures on the longitudinal were slightly higher (5%) than on the lateral tubes. Immersion of each subject differed. There was a marked difference in the immersion of the heavier subject – 421 sensors in the longitudinal configuration compared to 382 sensors in the lateral configuration. There was no appreciable difference in the amount of immersion of the lighter patient into the two surfaces.
Immersion of each subject differed. There was a marked difference in the immersion of the heavier subject – 421 sensors in the longitudinal configuration compared to 382 sensors in the lateral configuration. There was no appreciable difference in the amount of immersion of the lighter patient into the two surfaces.

2. Amount of surface accommodation to movement – This was calculated using the difference in peak pressures between the returned-to-flat position and the initial flat position. When the bed was flattened after gatching to 30°, peak pressures on the longitudinal cylinders decreased 3% for the female subject and 25% for the male subject compared with peak pressures before gatching. Peak pressures on the lateral cylinders increased 21% for the female subject and 31% for the male subject. This would be significant in the “real world” setting, as it demonstrates what the sacral pressures would do as the head of the bed is elevated and lowered.

3. Pressures with the head of the bed elevated 30° (“gatched”) – Longitudinal cylinders gave lower peak pressures than lateral cylinders for both subjects. The pressures on the longitudinal cylinders were 33% better for the female subject (80 vs. 60) and 21% better for the male subject (100 vs. 79). The following mappings are of the male subject in the 30° gatched position. The top picture illustrates the pressures on the lateral cylinders, and the bottom picture illustrates the pressures on the longitudinal cylinders. The maximum pressure on the lateral cylinders again exceeds 100, while the maximum pressure on the longitudinal cylinders was 79.

CONCLUSIONS: Lateral cylinder support surface configurations do not appear to offer significant benefits to pressure management over longitudinal support surface cylinder configurations.

In fact, the longitudinal appears to be at least as good as, if not better than, the lateral cylinder configuration in managing pressures in the supine and 30° elevated positions. When the head of the bed was returned to the flat position after being elevated, the maximum pressures on the body increased on the lateral cylinders, and decreased markedly on the longitudinal cylinders.
Todd Batt, BSME, is a graduate of the Mechanical Engineering Department of Clarkson University in Potsdam, NY. He has worked in the field of Rehabilitation Technology in both patient service and research since 1994, and is currently employed by the South Carolina Vocational Rehabilitation Department in Columbia, SC. He is a member of the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA).

### TABLE 1: Subject 5’ 3” 120 lb. female

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lateral Tube Configuration</th>
<th>Longitudinal Tube Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned to flat</td>
<td>Maximum pressure: 100</td>
<td>Minimum pressure: 59</td>
</tr>
<tr>
<td></td>
<td>Average pressure: 16.4</td>
<td>Average pressure: 14.6</td>
</tr>
<tr>
<td></td>
<td># of sensors: 315</td>
<td># of sensors: 305</td>
</tr>
<tr>
<td>Initial Bed Flat</td>
<td>Maximum pressure: 83</td>
<td>Minimum pressure: 61</td>
</tr>
<tr>
<td></td>
<td>Average pressure: 16.1</td>
<td>Average pressure: 15.2</td>
</tr>
<tr>
<td></td>
<td># of sensors: 306</td>
<td># of sensors: 305</td>
</tr>
<tr>
<td>Change in maximum pressures following bed position change (Returned to flat – Initial bed flat)</td>
<td>Increased: 21%</td>
<td>Decreased: 3%</td>
</tr>
</tbody>
</table>

### TABLE 2: Subject 5’ 10” 180 lb. male

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lateral Tube Configuration</th>
<th>Longitudinal Tube Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned to flat</td>
<td>Maximum pressure: 76</td>
<td>Minimum pressure: 64</td>
</tr>
<tr>
<td></td>
<td>Average pressure: 19.9</td>
<td>Average pressure: 19.3</td>
</tr>
<tr>
<td></td>
<td># of sensors: 390</td>
<td># of sensors: 406</td>
</tr>
<tr>
<td>Initial Bed Flat</td>
<td>Maximum pressure: 58</td>
<td>Minimum pressure: 80</td>
</tr>
<tr>
<td></td>
<td>Average pressure: 20.4</td>
<td>Average pressure: 21.4</td>
</tr>
<tr>
<td></td>
<td># of sensors: 373</td>
<td># of sensors: 383</td>
</tr>
<tr>
<td>Change in maximum pressures following bed position change (Returned to flat – Initial bed flat)</td>
<td>Increased: 31%</td>
<td>Decreased: 25%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lateral Tube Configuration</th>
<th>Longitudinal Tube Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOB elevated 30°</td>
<td>Maximum pressure: 80</td>
<td>Minimum pressure: 60</td>
</tr>
<tr>
<td></td>
<td>Average pressure: 15.6</td>
<td>Average pressure: 14.1</td>
</tr>
<tr>
<td></td>
<td># of sensors: 322</td>
<td># of sensors: 316</td>
</tr>
</tbody>
</table>
THE SCIENCE BEHIND THE HEEL SLOPE®
HEEL PROTECTION DESIGN

Heels are the second most common site for pressure ulcers, second only to the sacrum. By virtue of its thinly padded surface, relatively poor blood supply, and difficult anatomical design for offloading, the heel is especially vulnerable to tissue damage. Ulcers here are also difficult to heal, due to these same reasons.

In order to help to reduce the incidence of heel breakdown, all Geo-Mattress and PressureGuard products are designed with a Heel Slope. The foot end of the mattress slopes down to increase load on the calves and decrease load on the heels. On average, heel pressures are reduced by about 27% with this design compared to flat designs.

A flat surface does not conform to the shape of the lower leg, especially behind the Achilles tendon.

Result: Heel must bear excess load, and skin will break down more easily.

The Heel Slope slightly lowers the heel, allowing the mattress to fill in the space behind the Achilles tendon.

Result: Pressure is distributed over the entire lower leg, reducing pressure on the heel.
SPAN AMERICA GEO MATTRESS ABSTRACTED STUDIES

A Comparative Study of Interface Pressures on Two Hospital Polyurethane Foam Mattresses
Gregory W. McGrew, MEBME; Whitten Center, Clinton, SC
Clinical Reports: Series on Skin and Wound Care Management, December 1997
The Heel Slope feature on the Geo-Mattress Max reduced pressure from the heels by an average of 27% as compared with the MaxiFloat® LXP Mattress.

Replacement Mattress Evaluation: Geo-Mattress® Max
Judy Murphy, RN, BSN; Material Management, North Mississippi Health Svcs, Tupelo, MS
Clinical Reports: Series on Skin and Wound Care Management, September 1998.
This write-up is the result of a blinded head-to-head comparison among three all-foam replacement mattresses: Geo-Mattress Max (Span-America), Maxifloat (BG Industries), and Prima Shearless (Hill-Rom). The Geo-Mattress Max was the clear winner in Clinician Satisfaction, patient Satisfaction, and Patient Comfort, and equivalent to the other two surfaces in Skin Assessment. The Geo-Mattress Max was selected as the surface of choice for this 350-bed acute care hospital.

Quality Improvement in Patient Treatment and Cost-Effective Care With Geo-Mattress® Pro
Judy Hussey, RN, BSN, Florida State Hospital, Chattahoochee, FL
This 900-bed facility replaced 120 of their mattresses in Acute Care, Skilled Care, and Geriatrics Units with the Geo-Mattress Pro. This mattress was used for prevention, and for early treatment of skin breakdown. Rented powered mattresses were allowed for Stage 3 or 4 ulcers, or for those patients who could not be positioned off of their ulcer sites. Data was collected three months prior to placement of the mattresses, and three months after placement. Monthly incidence rate of skin breakdown decreased by 50%. In addition, the cost of rented treatment mattresses decreased 81%, from an average of $6,446/month to $1,229/month.

Copies of any of the above articles and testimonials can be obtained on request.
Please contact Customer Service at 1300-930-930.
Address questions to Luke Craddock, Manager of National Accounts - luke.craddock@alphacare.com.au